Practical Time Series Analysis

BANA 4090

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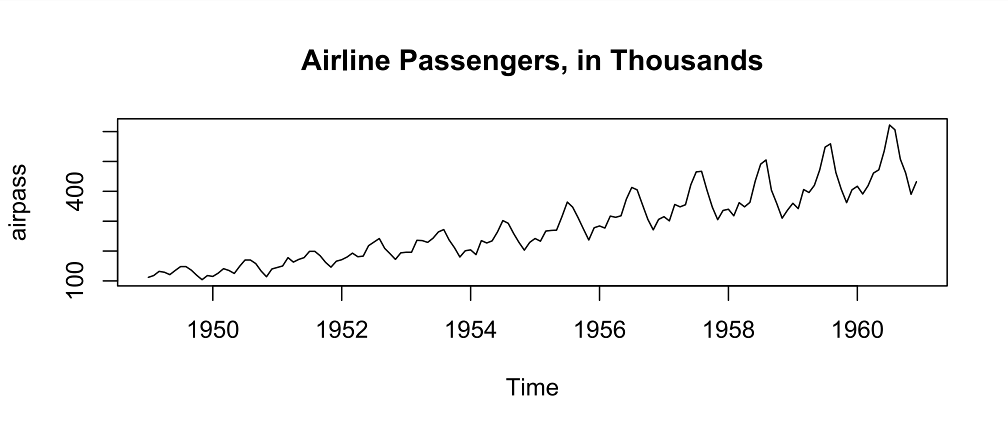
Chapter 1

Time series data

- Time series data form an ordered sequence of numbers, corresponding to an object like quantities, prices,counts, observed at or over a particular point **in time**.
- The "Airline Passengers" data set is an example of **time series data**.

```
plot(airpass)
title(main="Airline Passengers, in Thousands")
```



Time series patterns

- Describing a time series: trend, seasonality, cycles, changing variance, unusual features.
    - **Trend**: pattern exists when there is a long-term increase or decrease in the data.
    - **Seasonal** : pattern exists when a series is influenced by seasonal factors (e.g., the quarter of the year, the month, or day of the week).
    - **Cyclic** : pattern exists when data exhibit rises and falls that are *not of fixed period* (duration usually of at least 2 years).

Seasonal or cyclic?

Differences between seasonal and cyclic patterns:

- seasonal pattern constant length; cyclic pattern variable length
- average length of cycle longer than length of seasonal pattern
- magnitude of cycle more variable than magnitude of seasonal pattern

The timing of peaks and troughs is predictable with seasonal data, but unpredictable in the long term with cyclic data.

Visualizing time series data in R

- Visualization is good practice to be able to understand the properties of the data.
  - Most time series coming from official data sources provide recordings at a regularly spaced set of such time points, such as every day, week, month, quarter, or year; this interval is called the **frequency** of the time series.
- A time series is stored in a `ts` object in R:
  - `ts` objects and `ts` function

For observations that are more frequent than once per year, add a `frequency` argument.

E.g., monthly data stored as a numerical vector `z`:

```
y <- ts(z, frequency=12, start=c(2003, 1))
```

Chapter 2

Correlation

- Correlation: measure of linear relationships (**a measure of the direction and strength of the relationship between two variables**)

- We use Pearson's r as a measure of the linear relationship between two quantitative variables. In a sample, we use the symbol r . In a population, we use the Greek letter ("rho"). Pearson's r can easily be computed using R.

- The correlation coefficient, rho, measures linear relationships: Ranges over [-1, +1]

    - A value of +1 indicates a perfect positive (upward sloping) linear relationship between the two variables.
    - A value of -1 indicates a perfect negative (downward sloping) linear relationship between the two variables.
    - A value of zero indicates no linear relationship between the two variables.

Interpret correlation coefficient

- Correlation coefficient is comprised between -1 and 1:
  - -0.86 indicates a strong negative correlation : this means that every time x increases, y decreases.
  - 0 means that there is no association between the two variables (x and y).
  - 0.87 indicates a strong positive correlation: this means that y increases with x .

Note: The closer r is to 0 the weaker the relationship and the closer to +1 or -1 the stronger the relationship (e.g., r=-0.98 is a stronger relationship than r=+0.78); the sign of the correlation provides direction only.

Interpret correlation coefficient

- To determine whether the correlation between variables is significant, compare the p-value to your significance level. Usually, a significance level (denoted as α or alpha) of 0.05 works well.

- An α of 0.05 indicates that the risk of concluding that a correlation exists—when, actually, no correlation exists—is 5%. The p-value tells you whether the correlation coefficient is significantly different from 0. (**A coefficient of 0 indicates that there is no linear relationship.**)

  - **P-value ≤ α**: The correlation is statistically significant. If the p-value is less than or equal to the significance level, then you can conclude that the correlation is different from 0.
  - **P-value > α**: The correlation is not statistically significant. If the p-value is greater than the significance level, then you cannot conclude that the correlation is different from 0.

Questions? 😄